

JUNIPERUS TEXENSIS SP. NOV. - WEST-TEXAS JUNIPER
IN RELATION TO J. MONOSPERMA, J. ASHEI ET AL.

P. J. van Melle

JUNIPERUS TEXENSIS SP. NOV.

J. monospermae (Engelm.) Sarg. similis sed galbulis non glaucescentibus nunquam coeruleis violaceisve, ante maturitatem in vivo viridibus in sicco brunneis, maturis in vivo siccoque brunneis raro roseis rubrisve, post maturitatem surde griseo-brunneis vel griseo-purpurascensibus, hilo longitudine dimidio seminis differt. Floribus vulgo dioicis raro (ut in typo) monoicis.

TYPE: J. F. Brenckle 51019, Big Bend National Park, Brewster Co., Texas; deposited in the N. Y. Bot. Gdn. Isotype at the Arnold Arboretum.

SPECIMENS

Texas Agricultural Experiment Station, Sonora: Cory 38605, 38606, Brewster Co., Tex.; Hindckley 2594, Presidio Co., Tex. New York Botanical Garden:

Texas. Terrell Co.: Muenscher & Muensch. 14484; van Melle 502, 503, 504, 505. Brewster Co.: Brenckle 51018; Ferris & Duncan 2830 (cf. Martinez, Jun. Mex. in An. Inst. Biol. 17, Nos. 1, 2 : 108, 1946); C. H. Mueller 7945; Muenscher & Muns. 14488, 14534; P. Koch 3, 6 (both rose-fruited variants), 4; E. J. Palmer 34142; van Melle 517. Presidio-Brewster Co.: Hanson 632. Guadalupe Mts.: Moore & Steyermark 3418, 3520 (cf. Steyerm. & Moore in An. Mo. Bot. Gdn. 20 : 812, 1933). Jeff Davis Co.: van Melle 518, 519. Howard Co.: Palmer 33998; Ross, Standley & Russell 12214. Mitchell Co.: van Melle 520, 521, 522. Nolan Co.: Palmer 34593. Floyd Co.: Ferris & Duncan 3365-A. Paloduro Canyon: Brenckle 51011, 51012. "N. W. Texas": Buckley anno 1875.

Probably intermediate between J. texensis and J. monosperma: Oklahoma: Goodman 2218, Cimarron Co. New Mexico: M. E. Jones 9.7.1903, Florita Mts. Arizona: Pringle 6.7.1882, Rincon Mts.; N. L. Goodding 1272, Mouth of Mohave Creek (Mohave Co.).

Probably intermediate between J. texensis and J. Ashei: Texas: Palmer 6555, Hood Co. (All the above intermediates at the N. Y. Bot. Gdn.)

DISTRIBUTION: Western Texas. In the southwestern mountains with J. Deppeana Steud. and here and there with J. monosperma; in the Chisos Mts. (Brewster Co.) also with J. flaccida Schl. Northward, it is the only Juniper on the slopes and plains to the east of the Staked Plains, and extends into the Paloduro Canyon, where it occurs with J. monosperma and J. Pinchotii Sudw. We have seen no material of it from the Edwards Pla-

teau, where J. Ashei Buchh. is reported to predominate (Hopkins in Rhodora 40 : 425, foot-note 3 1938; et al.). Eastern limit in northern Texas: about the 100th meridian.

With the exception of J. Deppeana and J. flaccida Schlecht., no other Juniper than J. texensis was seen by us along the following route travelled by us in western Texas in July, 1951:

Junction of the Pecos River and Rio Grande; U.S. Route 90 to Marathon (Brewster Co.); Big Bend National Park; Marathon; Route 90 to Alpine; Routes 118 and 17 to Pecos; thence eastward on Route 80 into Eastland Co. About $3\frac{1}{2}$ miles east of Ranger, Eastland Co., J. Ashei replaced our species along this route.

One would expect J. texensis to occur south of the Rio Grande; but we have seen no Mexican material of it.

COMPARATIVE DESCRIPTION.

Our species differs from J. monosperma only in its fruit and seed. It shows, in the adult foliage, the same inconsistent ratio of opposite to ternate leaves, and the same, wide variation of dorsal characters. In scattered stands on open slopes and levels it forms mostly a bushy tree with a crown built upon two or more main limbs ascending more or less widely from a point at or somewhat above the ground and much ramified in their upper parts; mostly not over 6 m high, but often taller in arroyos, canyons and wooded parts. In the Big Bend National Park we found it mostly much wider than high; along Route 118, along the fringes of the Davis Mts., relatively narrower, sometimes of equal height and width. In an area between the Big Bend National Park and the mouth of the Pecos River it remains mostly much lower and relatively wider, often approximately 1.5 x 4 m, but here, too, mostly much taller in arroyos, and occasionally in the open.

As in J. monosperma, the bark exfoliates in thin longitudinal strips.

But the fruit of J. texensis is conspicuously distinct. It has not the slightest trace of bluish or gray bloom. In living material it is, before maturity, as green as the foliage, and, at maturity, nut-brown or sometimes yellowish brown, rarely varying to shades of rose or bright brownish red. As it ripens and dries on the bush it turns mostly a dull gray to dull grayish brown or purplish gray. Fruit collected before or at maturity is, on herbarium sheets, a distinctive brown, by which the species is very readily distinguished from both J. monosperma and J. Ashei. Fruit collected after it has dried on the bush is likely to retain its dull color on the sheets, as in our No. 521. Mr. P. Koch, of the Big Bend National Park Photo Shop, writes me that he has seen only very few of the rose- or red-fruited variants; and I am not sure that when such fruit occurs, it persists throughout the plants on which they are found.

In the Big Bend the mature fruit is mostly globose and about

5 mm long and wide, but sometimes to 7.5 mm. Farther north it varies freely to a conico-ovoid shape and is often to 7.5 mm long.

Mr. Koch writes me that the occasional red fruits are eaten by Townsend Solitaires from late October on. This would indicate that it ripens at that time. He writes, further, that the birds leave the somewhat drier, duller fruit alone, and that it remains and dries on the bush. In July, 1951, we found dry fruit persisting, apparently abnormally late, in only a single bush (our No. 521), in Mitchell Co.

The ripe fruit, though somewhat juicy, is less so, and less coarsely wrinkled, and dries and hardens less slowly than that of J. monosperma, which, not rarely, remains quite resilient on herbarium sheets some 25 to 35 years old.

The ripening season of the fruit appears to vary somewhat between the southern and northern extremities of the distribution. We have seen collections of apparently newly matured and maturing fruit made between early January and the middle of March. From data at hand we conclude that the fruit of J. texensis ripens within a year from the time of its inception.

There are predominantly 1 or 2 seeds to a fruit in individual plants or small communities of them. Fruits with 3 seeds occur only very occasionally and apparently never consistently in any one plant.

Basing comparisons upon large quantities of fully matured solitary seeds, we find that those of J. texensis are of somewhat smaller average size than those of J. monosperma and have a relatively larger hilum, the larger lobe of which reaches about halfway up the surface, against hardly 1/3 of the way in J. monosperma. In both kinds there are usually some 3 to 5 more or less clearly or vaguely defined longitudinal grooves extending upward from near the base; often 2 or 3 placed a little higher up, and sometimes one or more located entirely above the middle.

RELATION TO EARLIER PUBLICATIONS

J. texensis has been vaguely included in treatments of J. monosperma - more as to distribution than description. Actually, the latter species spills over into Texas from New Mexico into the southwestern mountains, and occurs, farther north, in the Staked Plains and in the Paloduro Canyon and beyond it in the Panhandle. In the mountains it is represented by the following specimens in the N. Y. Bot. Gdn. Herbarium: Hinckley 801, Chinati Mts., Presidio Co.; Waterfall 4800, Sierra Diabolos, Hudspeth Co., and 4990, Culberson Co; Koch 5. We did not see it in the Big Bend National Park; but Cory's type specimen of J. erythrocarpa, at the Arnold Arboretum, from the base of Mt. Emory, in the Park, appears to us as conspecific. Koch 5 is, also, from the Park. In the Panhandle, notably in the Paloduro Canyon, J. monosperma occurs with J. Pinchotii.

As for J. Pinchotii, it seems to us that Sudworth's publication of that species (cited below) hardly represents a contrast with J. monosperma, but rather with the less juicy- and duller-fruited J. texensis. The only element in this original description that distinguishes J. Pinchotii from J. monosperma is the "large hilum" of the seed. We find, moreover, that the seeds of J. Pinchotii are of somewhat smaller average size than those of J. monosperma.

The difference between the two kinds is slight. Yet it appears to us to have some significance, and to merit recognition. We therefore place Sudworth's Juniper in varietal rank under J. monosperma, as follows:

JUNIPERUS MONOSPERMA (Engelm.) Sarg. var. PINCHOTII (Sudw.)
Comb. nov.

J. Pinchotii Sudw. in For. & Irrig. 11 : 204 (1905).

A speciei typo seminibus minoribus hilo dimidio seminum longitudine differt.

The difference in relative length of the hilum, best observed in solitary seeds, is clear and consistent to us in a comparison of some 1500 seeds of each of the two kinds.

We have seen specimens of the variety from the following localities: Texas, Armstrong, Briscoe and Randall Counties. Oklahoma, Cimarron Co.

It seems to us that many specimens have been identified as J. Pinchotii on the basis of their localities rather than that of the relative length of the hilum.

We regard the variety not as of lesser philogenetic rank than the nomenclatural type, but simply as a slightly distinct phase of the species.

As to J. erythrocarpa, described by Cory in Rhodora 38 : 186 (1936) as a species distinct by its red fruit and seed characters - we conclude, from examination of his type specimen (Cory 7642, at the Arnold Arboretum) that it is conspecific with J. monosperma, differing from it by the relatively larger hilum of the seed. The grooves on the seed appear to be particularly well defined but we do not think that they constitute a clear-cut difference from typical J. monosperma, in which sometimes they are equally distinct. In all other respects J. erythrocarpa appears to us, from the type specimen, to represent the normally fruited J. monosperma, of which Cory described, in the same paper, the teratological material with exposed seed as J. gymnocarpa. In the same paper, also, he transfers J. occidentalis Hook. var. monosperma Engelm. to the species mexicana Spreng., which is now believed to equal the geographically rather remote, 3- to 4-seeded J. monticola f. compacta of Martinez (o.c. 85). In fact, Cory's over-all picture of the monosperma situation does not seem very clear.

His type sheet of J. erythrocarpa contains, besides several normal fruits, one abnormally developed one of brownish-violet color, about 7 x 5 mm, as well as a number of abnormal processes with elongated, supernumerous floral scales. The rather pointed leaves of the specimen are not unusual in J. monosperma. The large hilum matches that of the var. Pinchotii, from which variety Cory's Juniper may not be clearly distinguishable and to which, upon examination of additional material, we may want to refer it. To date we have seen only one collection, Koch 5, from the Big Bend National Park, which matches Cory's type specimen as to fruit and seed.

Meanwhile, the name J. erythrocarpa invites confusion with the more strikingly erythrocarpous forms of J. texensis. Prior to our examination of Cory's type we supposed that the name covered the rose- to red-fruited forms of our J. texensis, and that the brown-fruited material of our species was, therefore, conspecific with J. erythrocarpa. Under that impression we so misidentified one of three specimens of our J. texensis from the Texas Agricultural Experiment Station (Hinckley 2594). The other two sheets (Cory 38605, 38606) had been so identified by I. W. Johnston.

J. texensis is not likely to be confused with its easterly neighbor, J. Ashei, in which the fruit, in living material, is, before maturity, bright-blue and at maturity, living and preserved, a very dark blue. Though there is only little pulp, the fruit is quite juicy. The seeds (1 or 2) are only faintly pitted or grooved, or both, and the small hilum is of the same relative length as in J. monosperma.

Along Routes 80 and 67, eastward of Ranger, Eastland Co., Texas, J. Ashei mostly resembles J. texensis in habit, but is, generally, of somewhat lesser relative width; often with obliquely diverging limbs ascending in their upper parts; varying to rather narrow, nearly erect, plural stemmed trees, often to 8 m high. Buchholz, in his original description (Bot. Gaz. 90 : 329, 1930) mentions heights of 12 to 20 ft. in northwestern Arkansas; Palmer (43032, 43986) indicates heights of 10 to 15 m in the Arbuckle Mts. in Oklahoma.

The color of the adult foliage is mostly deeper green than in J. texensis; the lesser branches are less rigid, and the terminal shoots are often drooping, like those often seen in J. virginiana L. The ultimate adult branchlets are mostly thinner than in J. texensis, and thicker than in J. virginiana. Particularly in the more narrow and more erect plants there is considerable resemblance to J. virginiana, except for the consistent plural-stemmed habit.

In fact, it is difficult to avoid the impression that J. Ashei shows signs of intermediacy between J. texensis and J. virginiana. More particularly, it is in the northerly material that there appears a strong influence of J. virginiana, while

in the more southerly, in the general vicinity of Austin, Tex., there appears to be a strong infusion of J. silicicola (Small) Bailey.

We think of J. Ashei, then, not in terms of a hybrid species of recent origin, but as a pretty well jelled, though not comparatively old species of composite derivation. But before venturing more detailed speculation as to its origin, let us return to J. texensis.

GROUND'S FOR SPECIFIC STATUS OF J. TEXENSIS

Despite admitted resemblances between it and J. monosperma we refrain from publishing it as a variety of the last-named because of a belief that the two taxons do not represent, simply, two varietal phases of a single species. We think that, of the two, J. texensis represents the more primitive species, and J. monosperma a more recent one of composite derivation, involving, on the one hand, J. texensis and, on the other, an eastern Red Cedar influence. We believe that J. monosperma is of the same basic derivation as is J. Ashei, but that the texensis influence is more prominent in it than in J. Ashei.

Our diagnosis of J. texensis as a comparatively primitive species, based upon a monoecious type, proceeds from a view that appears not to have been applied by others to the study of Junipers, but which appears to us as helpful in the discernment of patterns of relationships and distributions. It is this: that the occurrence of monoecism in Junipers is indicative of comparatively primitive stocks.

It appears to be a well established opinion (Arnold, Intr. Paleobot. 325, 1947) that, in relation to the Pinaceae, the Family Cupressinaceae (or the Subfamily Cupressineae) constitutes for the greater part a comparatively recent group. In it appears a trend toward the breaking up of the monoecism of the older group into a more specialized, dioecious biosis. This trend comes into view clearly in the genus Juniperus, in which may be observed both monoecious and dioecious as well as transitional phases.

In our Review of J. Chinensis et Al. (N.Y. Bot. Gdn., 1947) we applied this view to the restoration of J. sphaerica Lindl., calling attention to the occurrence in it of the three phases - the transitional represented by belatedly monoecious materials in which pistillate flowers appear in plants of a more or less advanced (sometimes considerable) age.

We do not mean, here, to go into a lengthy discussion of our view which, with pertinent data, might well furnish subject matter for a separate paper. But we venture to present, here, a few of the indications yielded by the study of the phenomenon of monoecism - which we have limited to the heterophyllous Junipers.

It seems, for instance, that monoecious elements of species never occur in a casual, scattered manner, but always by way of monoecious "cores", so located as to constitute probable centers of origin of dioecious distributions, whether of a single or of several species. Once broken up, it seems that monoecism does not recur.

It appears, also, that, around the world, monoecious "cores" occur in only a few areas, which may contain the monoecious elements of a single or of several species. For instances, in and about Turkey and certain coastal parts along the Black Sea occurs the monoecious element of one, distinct relationship. Here is found the largely monoecious J. excelsa Bieb., of which J. isophyllos C. Koch appears to be only a somewhat modified, dioecious development. But of the large group of Asiatic one-seeded heterophyllae, some 15 or 16 species of which have been published, it seems that all the known monoecious elements are concentrated in a relatively small, contiguous area, comprising Sikkang, southern Kansu, parts of Szechuan Province, part of the Ku-Ku-Nor Range and possibly adjacent parts of Yunnan - while dioecious phases, species and derivatives are spread over large parts of central Asia.

In fact, more often than not, monoecious elements are found clustered together in what may well be taken for centers of origin. For instance, those of J. Sabina L. and of J. phoenicea L. concur in southeastern France and adjacent parts of the Pyrenees, at the western end of their obvious eastward distributions. In and about Chekiang Province, China, occur the monoecious elements of J. sphaerica and of J. Sheppardii van Melle, dioecious radiations of which can be traced readily in every direction.

Known monoecious "cores" are in some instances large in relation to the distribution of their dioecious developments, as in the case of J. osteosperma (Torrey) Little - even if one includes in the over-all dioecious distribution J. californica Carr., which would seem to represent a somewhat modified, dioecious development of J. osteosperma. More often monoecious "cores" are relatively smaller, as in the case of J. Sabina. In some cases they represent probably mere remnants. There are undoubtedly one or more undiscovered "cores"; and possibly one or more are extinct.

With allowance for undiscovered "cores", it seems that in every one of the major, distinctive types in which the heterophyllous Junipers may be readily grouped a monoecious "core" exists. The most important instance known to us of an undiscovered "core" is that of the Red Cedar group of eastern North America, continental and insular. Though there is repeated mention in literature of monoecious material of "J. virginiana", we have not seen indication of its geographical location; and there is, moreover, a probability that the name

J. virginiana was used in such instances for some other species of the Red Cedar group.

In the case of J. flaccida - a very distinct species with a wide distribution in Mexico, spilling over into the Big Bend National Park - no reference to monoecious material is known to us in literature. We have seen only imperfect evidence of it. Brenckle 51017, from the Park, contains, besides abundant staminate cones, two or three abnormal processes which appear to represent pistillate inflorescences stung by an insect into a development of supernumerous, elongated scales - an injury to pistillate inflorescences which is very commonly found on J. osteosperma and other species, as well as on the type sheet of J. erythrocarpa Cory. Imperfect though the evidence of the Brenckle sheet is, it is, nevertheless, evidence of monoecism. We deem it probable that more conclusive evidence of it will be found in the Big Bend National Park.

Martinez (o.c.) makes casual mention of monoecism in J. Deppeana, without geographical data. North of the Rio Grande there is the following evidence of monoecism in this species in the Herbarium of the N. Y. Bot. Gdn.: J. C. Blumer 1256, Paradise, Chiricahua Mts., Ariz., is annotated as representing three trees, staminate, pistillate and monoecious. Otto Kuntze 28239 "Arizona", without locality, is obscurely monoecious. We think that monoecious material of this species may occur also farther eastward. When we visited the Big Bend National Park in July, 1951, staminate cones were not, or only rarely and obscurely, in evidence. Yet we noted a few plants as possibly monoecious, including our No. 517.

It seems to us that, generally, monoecious elements may be regarded as the purest and most distinct evidences of their kinds. We have seen no evidence of monoecism in any Juniper of discernible composite derivation.

Available data on monoecious materials are inevitably incomplete. As far as they go they seem to point unanimously to the conclusion that monoecious elements are indicative of comparatively primitive stocks, and the areas in which they occur of probable centers of origin.

We have, therefore, based our J. texensis intentionally upon a monoecious type, J. F. Brenckle 51019, collected by Dr. Brenckle, of Milette, S. D., from a single plant in the Big Bend National Park on March 16, 1951, and kindly placed at our disposal by him. The plant growing immediately near that from which the type was taken, Brenckle 51018, is dioecious. It seems probable to us that additional monoecious material will be found in the Park, or perhaps also in other mountain ranges in southwestern Texas. The fact that no other monoecious material had come into our view among earlier collections leads us

to think that probably only a small remnant of a monoecious "core" exists in this species.

By our own reasoning we should be bound to accord to J. monosperma and to J. Ashei, also, the status of basic, primitive species in the event that monoecious material of them were found - in which case our speculations as to their composite origin would stand refuted. For the present it seems to us improbable that it will be found. The characters of both species appear to us as not original, but derived. It seems to us improbable that a primitive speciation should have occurred quite so devoid of discernible distinctive characters. Consider how very distinct are the American species known to contain dioecious elements: J. occidentalis, J. osteosperma, J. Deppeana, J. flaccida and J. texensis.

PROBABLE DERIVATION OF J. ASHEI AND J. MONOSPERMA

From the morphology of these species we judge that both are composites of, on the one hand, J. texensis, and, on the other, of J. virginiana.

J. virginiana extends into southwestern Oklahoma, where it is abundant in the Wichita Mts. - an area not very remote from the northern limit known to us of J. texensis. We deem it very probable that the two species overlapped, and that J. Ashei is a result of hybridity between them. This species is now abundant on the Arbuckle Plateau in south-central Oklahoma. It extends southward to near San Antonio, Texas, and eastward in northeastern Texas. It is known, also, from northwestern Arkansas and adjacent parts of Missouri and Oklahoma. It may be believed to occur, also, at points connecting the latter area with the Arbuckle Plateau or northeastern Texas.

There appears to us to exist a difference, not quite definable geographically, between the northerly materials which occur with and in proximity to J. virginiana, and those from the more southerly Austin - San Antonio area, which bear equally strong resemblances to J. sillicicola. The southerly material has thinner ultimate branchlets and often approaches the dorsal leaf characters of the last-named species. It seems probable to us that this southerly material may represent the result of back-crossing between J. Ashei and J. sillicicola.

As for J. monosperma - it seems probable to us that at some point in southwesternmost Oklahoma or in northwestern Texas it resulted from back-crossing of J. Ashei with northern material of J. texensis; and that it represents today one of two apparent well settled results from an originally probably more unsettled hybrid population; the other result being the var. Pinchotii. In other words, we seem to have, today, two discernibly distinct results of the supposed hybridity: J. monosperma, with the small hilum of J. Ashei; and the variety, with the larger hilum of J. texensis.

Our general picture, then, of the relationships dealt with in this paper is one of a comparatively primitive species, J. texensis, representing a northward, dioecious extension from a monoecious "core" in the Chisos Mts. in Brewster Co., Texas. At the northern end of its distribution, where it overlapped upon J. virginiana, hybridity between the two species is believed to have given rise to a hybrid species, J. Ashei, which found its distribution eastward and which extends along the eastern fringe of J. texensis. Subsequently, through back-crossing with J. texensis, in or near southwesternmost Oklahoma, another hybrid species is believed to have resulted: J. monosperma, which, through the northwest of Texas, passed into a large distribution westward, in southern Colorado, New Mexico, Arizona and northern Mexico.

We did not see J. Ashei along Route 90 between San Antonio and Del Rio; nor have we seen living or preserved material of it from between this route and the Rio Grande. Yet there appears to exist a strong resemblance between this species and the Mexican, slender-fruited, thin-branchleted J. monosperma var. gracilis of Martinez (Los Juniperus Mexicanos 109); and one easily supposes that a relationship exists between them. Investigation of it would involve an extension of the scope of the present paper which we must forgo - not, however, without pointing to the desirability of closer correlation between the admirable study by Martinez and available treatments of Junipers north of the Rio Grande.

Grateful acknowledgement is made of courtesies extended to the writer by the New York Botanical Garden, the Arnold Arboretum, the Texas Agricultural Experiment Station, and by Mr. Peter Koch, of the Big Bend National Park Photo Shop; particularly, by Dr. J. F. Brenckle, of Milette, S. D., in placing at our disposal valuable study material, collected by him.

S U M M A R Y

Available data on the occurrence of monoecism among the heterophyllous Junipers point to monoecious elements as indicative of comparatively primitive stocks, and to the areas in which they occur as probable centers of origin.

J. texensis sp. nov. is based upon a monoecious type.

J. Ashei is believed to be of composite derivation from J. texensis and J. virginiana; and J. monosperma, from J. texensis and J. Ashei.

J. Pinchotii is presented in a new combination as J. monosperma var. Pinchotii. J. erythrocarpa Cory is regarded as conspecific with J. monosperma and hardly distinct from the var. Pinchotii.